## SECTION 45

## SEISMIC DESIGN AND RETROFIT

### 1.45.1 GENERAL

1. The acceleration coefficient that shall be used in the design and retrofit of bridge structures shall be as indicated below on a County to County basis.

| Acceleration Coefficient | County |
|---|---|
| A = 0.10 | Atlantic, Cape May, Cumberland Salem |
| A = 0.15 | Burlington, Camden, Gloucester, Monmouth, Ocean |
| A = 0.18 | Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Morris, Passaic, Somerset, Sussex, Union, Warren |

2. Note: If a bridge structure is located on the border between two counties with different acceleration coefficients, the **larger** value shall be used.

### 1.45.2 SEISMIC DESIGN OF NEW HIGHWAY STRUCTURES

1. The seismic design of new highway structures shall follow the requirements of Division 1-A of the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges, with current interims.

2. The Seismic Performance Category (SPC), as indicated in Table 3.4 of the above AASHTO Specifications, shall be **Category B** for the entire State.

3. The AASHTO Specification provisions apply to bridge structures of conventional steel and concrete girder and box girder construction that have spans that are not greater than 150 meters.

The provisions contained in the AASHTO Specifications are minimum requirements. Suspension type bridge structures, cable-stayed bridge structures, arch type and movable type bridge structures are not covered by the AASHTO Specifications.

A seismic design is usually not required for buried type (culvert) bridge structures.

### 1.45.3 SEISMIC RETROFIT OF EXISTING HIGHWAY STRUCTURES

1. The seismic retrofit design of existing highway structures shall follow the guidelines of the FHWA publication titled "Seismic Retrofitting Manual for Highway Bridges" currently numbered as, FHWA-RD-94-052, May, 1995

   Highway structures shall be retrofitted to **Seismic Performance Category B**.

2. A Seismic Retrofit Report shall be prepared to provide a determination as to a bridge structure's eligibility for a seismic retrofit.

   a. A flow chart to provide guidance in determining if a bridge structure qualifies as a seismic retrofit candidate can be found on Page 1.45-5. The results of the analysis, performed in accordance with the flow chart, shall be provided in the Seismic Retrofit Report.

   b. In preparing the Seismic Retrofit Report, the following guidance shall be followed. Initially, seismic retrofitting of a bridge structure shall only be considered under the following conditions:

      - The planned work will involve widening of a deck by more than 30% of its area; or,
      - The planned work will involve an entire deck replacement; or,
      - The planned work will involve superstructure rehabilitation or replacement, major abutment or pier repairs to bearing seat areas or bearing repairs or replacement.

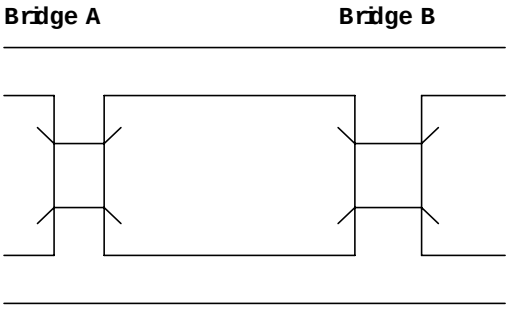
3. The Report should also include a study of a project to determine if retrofitting a bridge is a cost effective measure. The following areas should be addressed:

   a. An investigation to determine the extent of retrofitting which may be required.

   b. Prior to making a detailed evaluation of the seismic capacity of the bridge structure, the relationship of the bridge structure to other bridge structures on the route system, that may also be damaged during an earthquake, shall be considered.

      1.) Consider two bridge structures that have similar functions, such as bridge structures A. and B. as detailed on the next page. It is possible, that retrofitting bridge structure A., would be more economical or that bridge structure A. is more seismically adequate.

      2.) Accordingly, even though bridge structure A. is not in the project scope and bridge structure B. is, it would be more rational to retrofit bridge structure A. than bridge structure B.




4. Several methods of seismic retrofit are outlined for bearings and expansion joints within the FHWA Retrofit Manual that is referenced above. Of these methods the following are recommended for consideration in order of preference. If applicable, a recommendation as to the proposed treatment of a bridge structure should be included in the Seismic Retrofit Report.

   a. Modify existing bearings to resist seismic loads or to prevent toppling of existing bearings by installing longitudinal displacement stoppers.

   b. Longitudinal joint restraints as outlined in Subsection 5.2.1 of the FHWA Retrofit Manual.

   c. Bearing replacement with those type bearings described in Subsection 1.24.19 of this Manual.

      If conventional steel and elastomeric bearings, are proposed to remain, typical modifications to these bearings to withstand SPC Category B loadings would include the following:

      Modifications to Steel Bearings

      1. Increase size, number or embedment of anchor bolts.
      2. Increase the outer diameter of the pin head.
      3. Increase the width of the expansion rocker.
      4. Increase the top and bottom dimension of the pintle detail for increased movement.

      Modifications to Elastomeric Bearings

      1. Secure bearing against horizontal and vertical movement.
      2. Modify the plan area and/or thickness of the elastomeric bearing to reduce seismic forces to the substructure.

      The methods outlined above are recommended procedures and are not intended to restrict the ingenuity and creativity of the Design Engineer. Each bridge is different; therefore, retrofit procedures will be approved on a project to project basis by the Manager, Bureau of Structural Engineering.

5. If it is found through a seismic analysis that the substructure is in need of seismic retrofit, it will probably be economically advantageous to study

bearing replacement as part of a retrofit.

### 1.45.4 BEARINGS

1. Refer to Subsection 1.24.19 of this Manual for guidance in providing bearing designs to meet seismic requirements. The current AASHTO Standard Specifications for Highway Bridges should also be referred to for guidance in providing designs for pot, disc and elastomeric type bearings .

2. The AASHTO Guide Specifications for Seismic Isolation Design shall be used for designing isolation bearings when they have been deemed necessary for accommodating seismic loads. These bearings have special performance characteristics which will alter the dynamic response of a bridge.

   Superstructure forces can be reduced by factors of 2 to 5 in the lower seismic zones and there are corresponding reductions in the forces transferred to the piers and abutments.

## Additional Analysis Required for Existing Bridges Found in Planned Projects